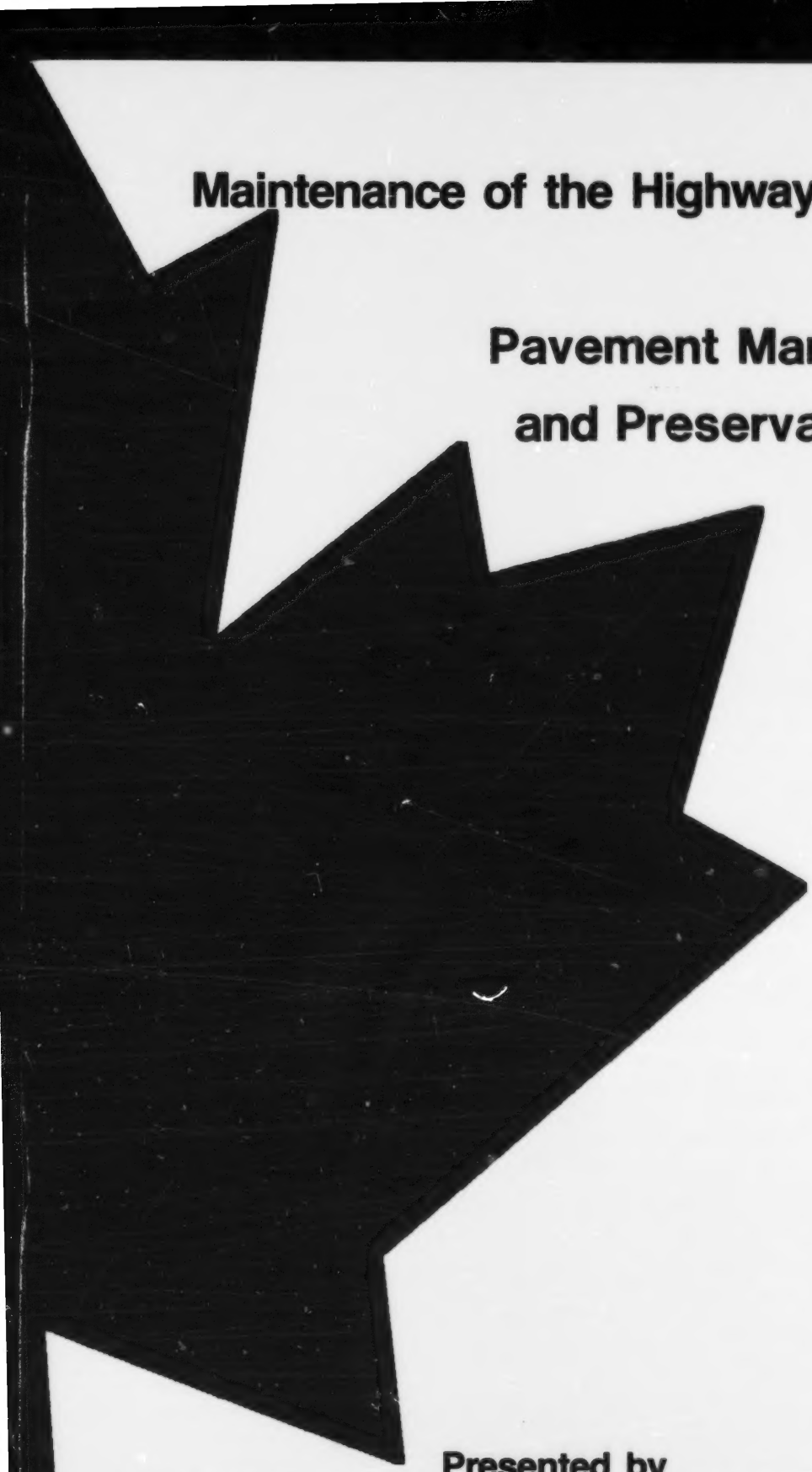
ONT 12

Maintenance of the Highway Infrastructure

Pavement Management and Preservation



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Maintenance of the Highway Infrastructure

Pavement Management and Preservation

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ABSTRACT

Recent emphasis on the preservation of the highway system in Ontario has sparked interest in the updating of processes and methodology by which major maintenance and the rehabilitation of pavements are managed.

A review of the existing management processes, developed many years ago when the system was being expanded, provides the background for the formulation of the new concepts, which are the subject of pilot implementation studies.

Upgrading of the methodology and processes is envisioned in several areas of network management. The areas detailed in this paper are associated with sectioning of the highway system, maintenance costing, pavement condition evaluation, function of a Pavement Management System (PMS) data bank, forecasting loss in serviceability, and development of an integrated maintenance and rehabilitation action plan for a five-year period.

These engineering-based action plans are optimized and integrated with financial planning and programming plans, while ensuring there is coordination between potentially conflicting maintenance and rehabilitation treatment types and schedules. The development of the action plans, encompassing involvement at all levels of technical and financial decision-making, is seen as enhancing the quality of the network plan. This proposal, which was extensively discussed with District, Regional, and Head Office personnel, is strongly supported at all levels of management concerned.

The methodology and processes detailed in this report are being tested and adjusted by implementing pilot studies in three Districts within three of our five Regions. After consideration and approval by management, it is expected that the system will be extended to cover the remaining 15 Districts in all Regions across the province.

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1/ INTRODUCTION

Road transportation in Canada is a responsibility of each provincial government. In the year ending March 1983, the province of Ontario spent about $540 million on the provincial King's Highways (approx. 25 300 km) and about $484 million on subsidies for municipal roads (approx. 131 300 km). Within the Ministry of Transportation and Communications (MTC), the Transportation Capital Branch is responsible for program planning and the development, priority setting, expenditure control, monitoring, and evaluation of the provincial highway program. One office of this branch, the Highway Program Planning Office, develops specific five-year highway program targets within given and estimated funding constraints and strategic planning guidelines, while another office of the branch, the Highway Program Administration Office, develops the operational plan for the first few years of the five-year program. Both of these offices work closely with the five Regional offices, who carry out the program, in developing program targets and operational plans.

In the past few years, the importance of maintenance and rehabilitation activities has been emphasized because of spending restraints. As a result, determined efforts have been made to improve rehabilitation planning, through the introduction of Program Analysis of Rehabilitation Strategies (PARS)[1]. As well, recent developments in computer technology have sparked interest in updating the processes and methodology by which major maintenance and rehabilitation are managed.

More recently, a task force has been working on the integration of pavement management system concepts into the current management processes for both maintenance and rehabilitation. These processes were developed many years ago when the highway system was being expanded.

This report outlines the concepts and processes which are envisioned in several areas of network management and describes the pilot studies in three Districts (one each in three of five Regions), which are intended to demonstrate how well these processes function.

2/ WHERE DOES A PAVEMENT MANAGEMENT SYSTEM (PMS) FIT?

Where do pavement management systems (network and project) fit into the current MTC management processes? Some insight into this question was gained from an 1983 article by Finn [2].

Figure 1 (adapted from Finn's article) shows that "network management" in MTC is within the functional areas for "planning" and "programming" and that "network optimization" is addressed by the Ministry's computer program PARS (Program Analysis of Rehabilitation Strategies) [3]. "Project management" is within the Pavement Design and Regional Geotechnical areas and is addressed, for new pavement construction, by the MTC computer program called OPAC (Ontario Pavement Analysis of Costs) [4]. For maintenance and rehabilitation there is currently no Ministry-wide optimization process; therefore, this aspect is addressed later in this report.

Central to all of these Pavement Management System (PMS) processes is a pavement management data base. At present, however, the MTC Highway Inventory is not capable of providing all of the necessary pavement management data (this is discussed in the following section).

Figure 2 shows the inputs required for network optimization in developing five-year planning target actions, costs, and system performance, while Figure 3, based on Reference 2, illustrates how project optimization translates these targets into specific job designs and specifications, which are later worked up into contract documents.

The "players" in MTC who already carry out some of the functions described above have been identified, and the additional functions and processes needed for an integrated PMS were noted in a previous pilot study report [5]. Table 1 shows the roles in pavement management of various groups in Head Office and the Regions.

In the present report, the changes which are necessary for implementation of the upgraded PMS are outlined for

- the data base, sectioning and programming;
- the condition index;

- performance prediction;
- alternative strategies;
- an integrated and co-ordinated five-year action plan.

3/ DATA BASE

The Highway Inventory in MTC is maintained by the Highway Program Planning Office, and it is based on data obtained from the Ministry's five Regions. The major data items collected for the Highway Inventory are principally related to geometric characteristics, such as pavement widths, and to traffic operations, for example, Annual Average Daily Traffic (AADT). The inventory sections therefore begin and end at features which relate to highway geometry and traffic (i.e., at changes in widths, at intersections, etc.).

For pavement management purposes, the data base sections should conceptually begin or end wherever changes in pavement performance can be expected. It is logical to expect these changes to take place at beginning and end points of construction contracts and at significant subgrade soil changes; i.e., pavement structure and subgrade support parameters should define PMS data base sections.

The criteria for sectioning the highway system for different purposes may or may not be compatible. For example, criteria for evaluating level of service of traffic operations may be quite different to those for evaluating serviceability of highway pavements. However, the Linear Highway Reference System (LHRS), based on a system of numbered nodes and an offset to define a point on a highway [6], can be used to tie different data bases together and to avoid duplication of data.

For network management purposes, a composite data base will need to be created, using pavement performance data for PMS data base sections annexed to whatever highway inventory data are relevant. Such a composite data base will contain, as far as is practical, historical profiles of the pavement structure and performance, as well as current conditions, including truck traffic, for pavement design and evaluation purposes.

The Highway Inventory and the pavement performance data bases are currently on an IBM 370 mainframe computer. New programming for the composite data base is being formulated to permit input and updating by each of the five Regions, with overall responsibility for the data base remaining with Head Office.

4/ PAVEMENT CONDITION INDEX (PCI)

In the past, MTC has evaluated pavement performance through the Pavement Condition Rating (PCR), taken at least every third year (annually in one Region). The PCR is a purely subjective rating assigned to a road section by one or more experienced pavement engineering staff, based on a set of word and picture guidelines [7]. PCR values trigger certain actions, such as making a section a candidate in the five-year pavement rehabilitation plan.

Because subjective PCRs create inconsistencies, and since a single PCR does not give clues as to future performance and may be as much as three years out of date, there is need to replace PCR as the planning parameter.

The measure proposed for replacing PCR is the Pavement Condition Index (PCI). Over the past few years, an investigation of how PCR is assigned has shown that PCR essentially comprises two elements -- riding quality and pavement distresses, which significantly affect ride quality [8]. In this investigation, PCR was correlated against a calculated PCI in such a way as to minimize scatter around a 45° line, by assigning appropriate weights to both riding quality (RCR) and to the various distresses which make up the sum of Distress Manifestations (DM). These findings were summarized as follows:

$$PCR = PCI = 100(0.1 \cdot RCR)^{1/2} \cdot \frac{320 - DM}{320} \qquad (1)$$

where RCR, the Ride Comfort Rating, is obtained either as a subjective rating or, preferably, is derived from a correlation between RCR and

roughness measured with mechanical devices such as PURD (an accelerometer mounted on a trailer axle) or the May's meter (excursions of a car rear suspension system) and DM is calculated from the check-off sheet (see Figure 4), as follows:

$$DM = \sum_{i=1}^{27} C_i(S_i + D_i) \qquad (2)$$

C_i = weighting value for a particular type of crack or other form of pavement distress (see Table 2).

S_i = weighting value for severity of crack or other form of distress (see Table 3).

D_i = weighting value for density of occurrence of the particular crack type or other form of distress (see Table 3).

A certain amount of historical data on PCRs is available over about 10 years, but detailed data used in the development of PCI are more limited and are only available for the last five years.

5/ PERFORMANCE PREDICTION

A requirement for evaluating the cost-effectiveness of rehabilitation alternatives and consequences of different spending levels is knowledge of the future performance of pavements and their maintenance and rehabilitation treatments. Available PCR data were analysed by Cook, Bacchus, and Kher using multiple regression techniques [3], and the results are summarized in the following equation:

$$P = P_0 - K_1 A^{K_2} \cdot M^{K_3} \cdot T^{K_4} \qquad (3)$$

where P = PCR

P_0 = initial PCR

A = age in years since last pavement overlay

M = overlay thickness
T = AADT (Annual Average Daily Traffic Volume)
K = constants which change with the Region

These prediction equations are currently being used in the development of five-year targets by the Highway Program Planning Office. However, it is clear that because of their limited scope, a great deal of future development is needed. Also, the regression route to the development of an expanded scope of these prediction equations may not be feasible because of a significant lack of data. A way in which the prediction data may be obtained in future is discussed in the following section.

Another facet of the prediction of pavement performance is the immediate effect of the proposed treatment on the PCR or PCI. For example, sealing cracks as a preventive treatment is unlikely to immediately change the present condition rating, but it ought to retard the future rate of change in PCI. Extensive hot-mix patching done as a corrective measure could immediately improve the PCR of the section, but would not change the overall rate of deterioration of the section in future years. Thus, in predicting the effects of applying a treatment, the immediate PCR change or jump, as well as the future rate of change in PCR, need to be given agreed values.

6/ ENGINEERING JUDGEMENT IN PREDICTION

During the development of a manual for choosing cost-effective corrective maintenance treatments [9], one of the major items quantified was the "expected effective life" of various maintenance treatments. These predictions of expected effective life, illustrated in Figure 5, really represent historical data because they were acquired by interview of over 50 persons, each of whom had at least 20 years of pavement maintenance-related experience [1]. The results of this work can be used as one set of information on maintenance, which can form a basis for the engineering judgements needed to develop predictions of performance for a co-ordinated maintenance and rehabilitation strategy.

One systematic way in which engineering judgement can be harnessed to provide predictions is the estimation of PCI_3, i.e., the prediction of the change in PCI envisioned at the end of a three-year period. It was the opinion of some pavement design engineers who had long experience in evaluating pavement performance that it was difficult to give a "judgement" on change in PCR in one, or even two years, but given historical PCR data and knowledge of local conditions, it should be possible to estimate change in PCR over three years.

In the case where rehabilitation is envisioned within the five-year period, an additional way in which this judgement may be harnessed is to obtain answers to the following questions:

- How long would the treatment delay the rehabilitation?
- What terminal PCI condition do you believe is desirable?
- How close to a PCI of 96 (the average condition of newly completed rehabilitation treatments) do you expect the pavement condition to be after application of the recommended rehabilitation treatment?

The success of this "engineering judgement" approach to performance prediction requires some consistency in application of knowledge which already exists in this area. To this end, a series of meetings was held with Regional Geotechnical staff, to synthesize the available information in some form of guidelines, with examples of use.

A method for capturing all of the "engineering judgement" for future analysis will also need to be developed.

7/ ALTERNATIVE STRATEGIES

Conceptually, there is an optimum maintenance and rehabilitation strategy applicable to every individual section of pavement. Developing these strategies can be difficult since there are so many unknowns to deal with. However, this is a problem which is amenable to the use of experience and engineering judgement -- not necessarily to identify what is optimum, but to at least outline which are feasible and practical alternative treatments.

The condition of the pavement, the class of highway, and past experience as to the success of various treatments in resolving problems in the old pavement are major factors in determining what can be done and in evaluating their cost-effectiveness. In the evaluation of alternatives for planning purposes, the costs used are average or benchmark figures.

It is also a necessary part of evaluating alternatives to set up performance criteria which will control the timing of application of treatments so that comparative analyses of alternatives are done on an equivalent performance basis.

Having decided on the timing of a technically feasible and a cost-effective treatment or strategy, consideration must also be given to the situation where postponement of this strategy is necessary to resolve budgeting problems. Here, it must be decided whether deferral of the treatment will necessitate adjustment to the quantities of the work or a change to a different treatment. The deferral is presumed to be for a two-year period.

The "routine maintenance only" alternative also needs to be considered when resolving budget problems. However, the effect on performance of routine maintenance only needs to be determined so that system condition assessments can be updated.

8/ FIVE-YEAR ACTION PLANS

For each highway section in the system, there should be a five-year plan covering the maintenance and rehabilitation strategies envisioned. For the major part of the system, only routine maintenance would apply. But for about 25% of the system, there will be suggestions for major maintenance and rehabilitation spread over the five years.

For each highway section, the major maintenance activities must be more closely co-ordinated with rehabilitation programs to avoid injudicious or repetitious expenditures. This will be accomplished by joint formulation of a five-year plan for the section. An example of the form that the

five-year action plan proposed for a section might take is illustrated in Figure 6.

This co-ordinated five-year plan will also need to be integrated into the five-year network plan through a process of Regional consolidation and iterative development of the network program between the Regions and Head Office. This iterative process is illustrated in Figure 7.

9/ TIME FOR DEVELOPING AND UPDATING ACTION PLANS

It is expected that 20 to 30% of all of the sections in the highway system will need to have co-ordinated action plans available for analysis in any given year.

Normally, the activities in Year 1 will have been funded and programmed, perhaps in categories of preventive maintenance, integrated normal and extraordinary corrective maintenance, and rehabilitation. (Reconstruction activities would not be included directly in the pavement management processes because these are triggered by deficiencies other than pavement performance, such as safety and capacity.) Activities planned for Year 2 will need to be re-evaluated in Year 1 and adjustments made to the action plans. Activities planned for Year 3 and beyond should be re-evaluated in Year 2, and the five-year action plan should be updated in Year 3.

10/ PILOT STUDIES

Pilot studies are underway in three Districts situated in three of the five Regions of the province. These studies entail the following:

- sectioning of the highway system by uniform pavement performance and development of guidelines for sectioning to match end points of inventory sections where practical;

- measurement of pavement roughness with a PURD (an accelerometer mounted on the axle of a trailer) and a May's meter as an objective measure of Ride Comfort Rating which, combined with distress manifestations, yields Pavement Condition Index;

- condition surveys;
- development of the structure and programs for the data bank;
- development of action plan format, criteria, and procedures for determining alternative strategies, their effects on PCI, and benchmark costs;
- generation of maintenance cost data for each section.

11/ CONCLUDING REMARKS

Potential improvements in the current pavement management processes in Ontario's MTC appear to lie in two major areas:
1/ improved pavement condition ratings for use in financial planning;
2/ improved co-ordination of maintenance and rehabilitation activities.

The institutional changes needed amount to the strengthening of the Head Office pavement evaluation function, to accommodate the carrying out of periodic pavement roughness measurements of the highway system and to act as custodian of the pavement management data base. As well, there is a need to recognize the necessary additional Regional geotechnical input and the development of appropriate training courses.

Certain adjustments to the management processes will also be necessary to enable the co-ordinated maintenance and rehabilitation activities to operate smoothly. Finally, as the results of the pilot projects become available, the Highway Program Planning and the Highway Program Administration Offices will need to actively participate in the development of these management process adjustments.

12/ REFERENCES

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[2] Finn, F.N., "Pavement Management Systems: Selecting Maintenance Priorities," Civil Engineering, ASCE, September 1983.

[3] "Program Analysis of Rehabilitation Strategies, PARS Report #9, An Up-To-Date Overview of PARS," W. Cook, York University, and R. Deighton, Capital Programs Branch, MTC, November 1983.

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[7] Chong, G.J., Phang, W.A., and Wrong, G.A., "Manual for Condition Rating of Flexible Pavement Distress Manifestations," MTC Report SP-004, Second Edition, April 1982.

[8] Phang, W.A. and Chong, G.J., "Ontario Flexible Pavement Distress Assessment for Use in Pavement Management," MTC Report PAV-81-01, presented at TRB, January 1982.

[9] Chong, G.J., Jewer, F., and Macey, K., "Pavement Maintenance Guidelines: Distresses, Maintenance Alternatives and Performance Standards," MTC Report SP-001, 1980.

Table 1/ Roles of Various Management Groups in PMS

	NETWORK MANAGEMENT		PROJECT MANAGEMENT	
ONTARIO MTC	PLANNING	PROGRAMMING	DESIGN	CONTRACT
HEAD OFFICE	•OPTIMIZES •PLANS •DEVELOPS TARGETS	•BUDGETS ALLOCATIONS •SCHEDULES	•SETS POLICY •SETS CRITERIA •SETS WARRANTS •CO-ORDINATES PMS ACTIVITIES •MANAGES PMS DATA BASE	•APPROVES •AWARDS
REGIONS (5)	•PROVIDES DATA •LISTS NEEDS	•JUSTIFIES •PRIORITIZES	•EVALUATES ALTERNATIVES •MEETS TARGETS	•CONSTRUCTS •ENSURES QUALITY
DISTRICTS (18)	•SUPPORTS REGIONS		•MAINTAINS	

Table 2/ Distress Weighting Factors and Description Codes

Pavement Distress Manifestations				
	Description		Code	Weight (C)
Surface Defects	1. Coarse Aggregate Loss		CA	3.0
	2. Ravelling		RA	3.0
	3. Flushing		FL	0.5
Surface Deformation	4. Rippling		RI	0.5
	5. Shoving		SH	0.5
	6. Wheel-Track Rutting		WR	3.0
	7. Distortion		DT	3.0
Cracking	8. Longitudinal Wheel Track	- single	S/LWT	1.0
	9.	- multiple	M/LWT	1.5
	10.	- alligator	A/LWT	3.0
	11. Mid-Lane	- single	S/ML	0.5
	12.	- multiple	M/ML	1.0
	13. Centre-Lane	- single	S/CL	0.5
	15.	- alligator	A/CL	2.0
	16. Meander	- single	S/ME	0.5
	17.	- multiple	M/ME	1.0
	18. Pavement Edge	- single	S/PE	0.5
	19.	- multiple	M/PE	1.0
	20.	- alligator	A/PE	1.5
	21. Transverse	- partial	P/TRV	0.5
	22.	- half	H/TRV	0.5
	23.	- full	F/TRV	0.5
	24.	- multiple	M/TRV	2.0
	25.	- alligator	A/TRV	3.0
	26. Random		RD	0.5
	27. Slippage		SL	0.5

Table 3/ Severity and Density Weights and Description Codes

Weight	Severity				Density		
D or S	Description	Code	Rut Depth (cm)	Crack* Width (cm)	Description	Code	% Length or Area
0	Very slight	0	<0.5	<0.7	Few	5	<10
1	Slight	1	0.5-1	0.7-1	Intermittent	6	10-20
2	Moderate	2	1-2	1-2	Frequent	7	20-50
3	Severe	3	2-5	2-3	Extensive	8	50-80
4	Very severe	4	>5	>3	Throughout	9	>80

* For cement-treated base, use 0.3 instead of 0.7.

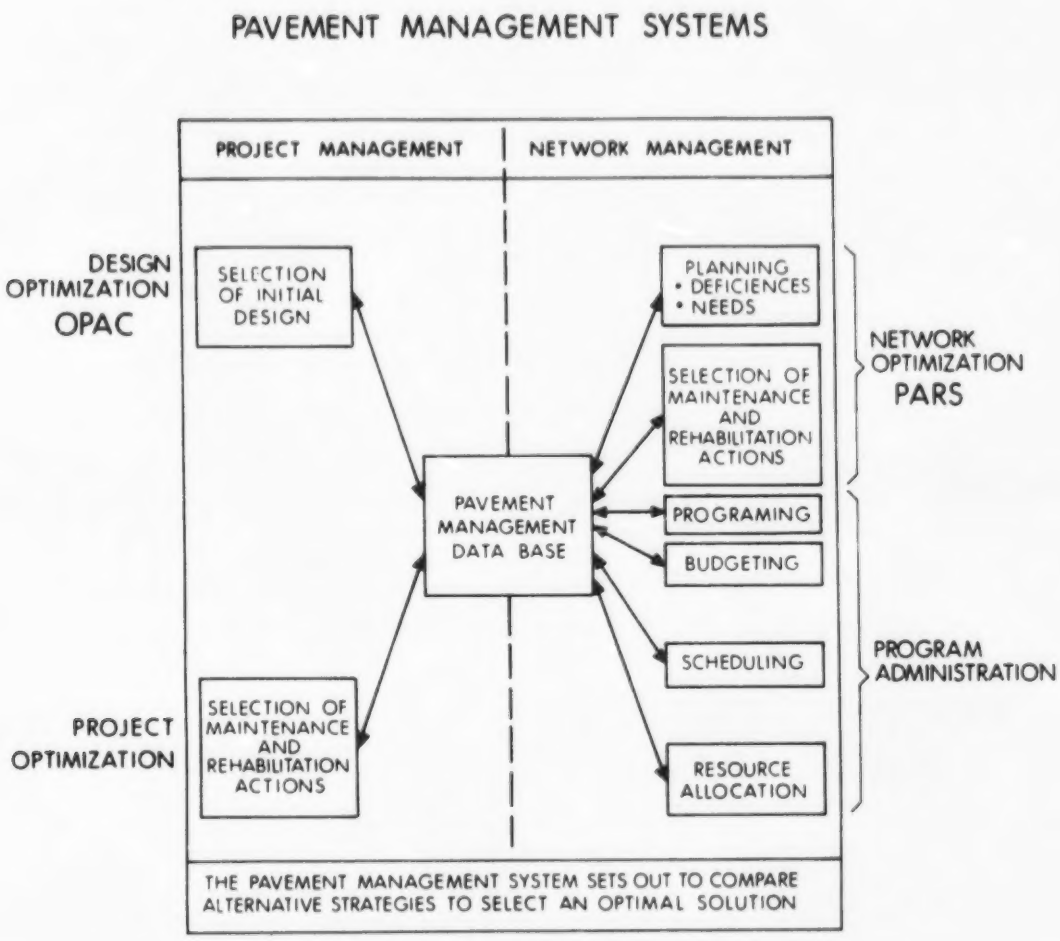


Figure 1/ Illustrating Network and Project Management Functions in MTC

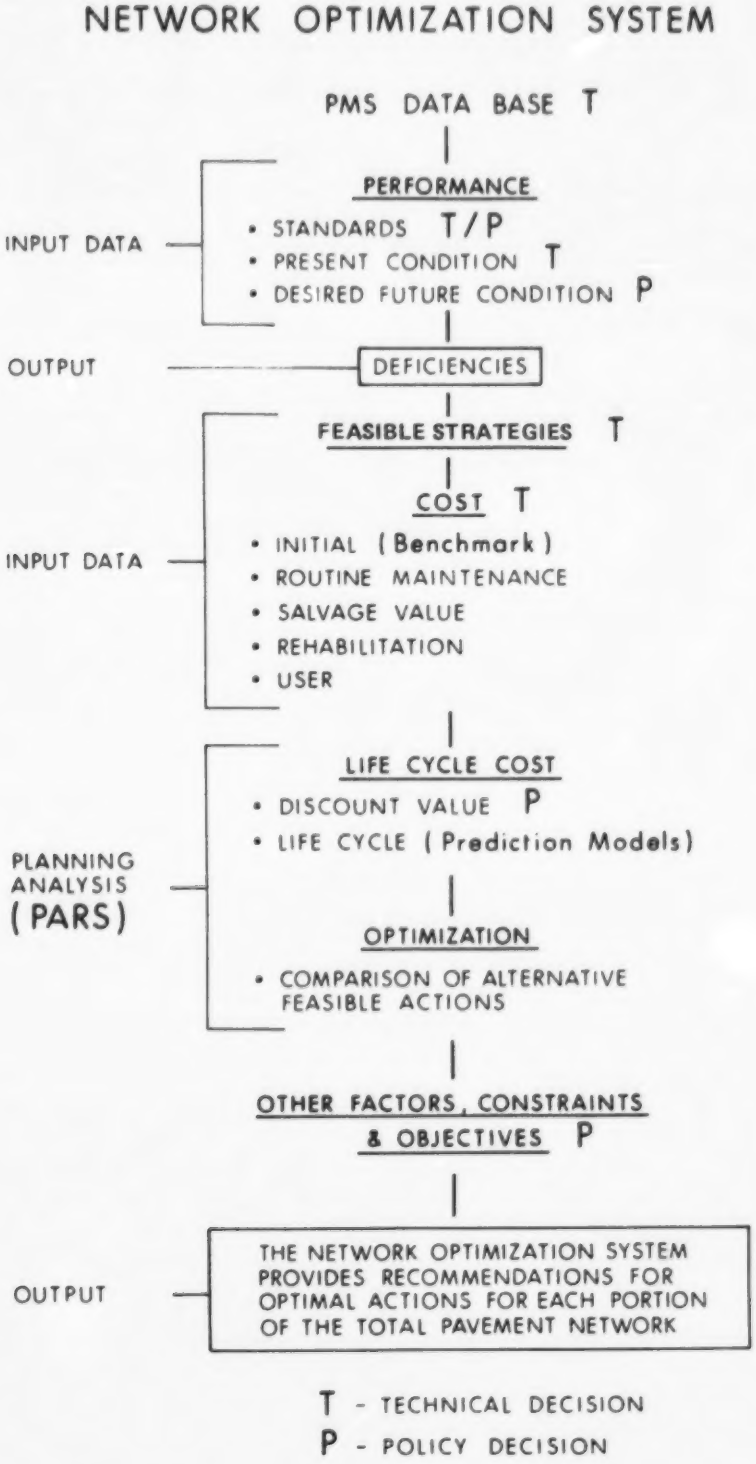


Figure 2/ Illustrating Network Management Products

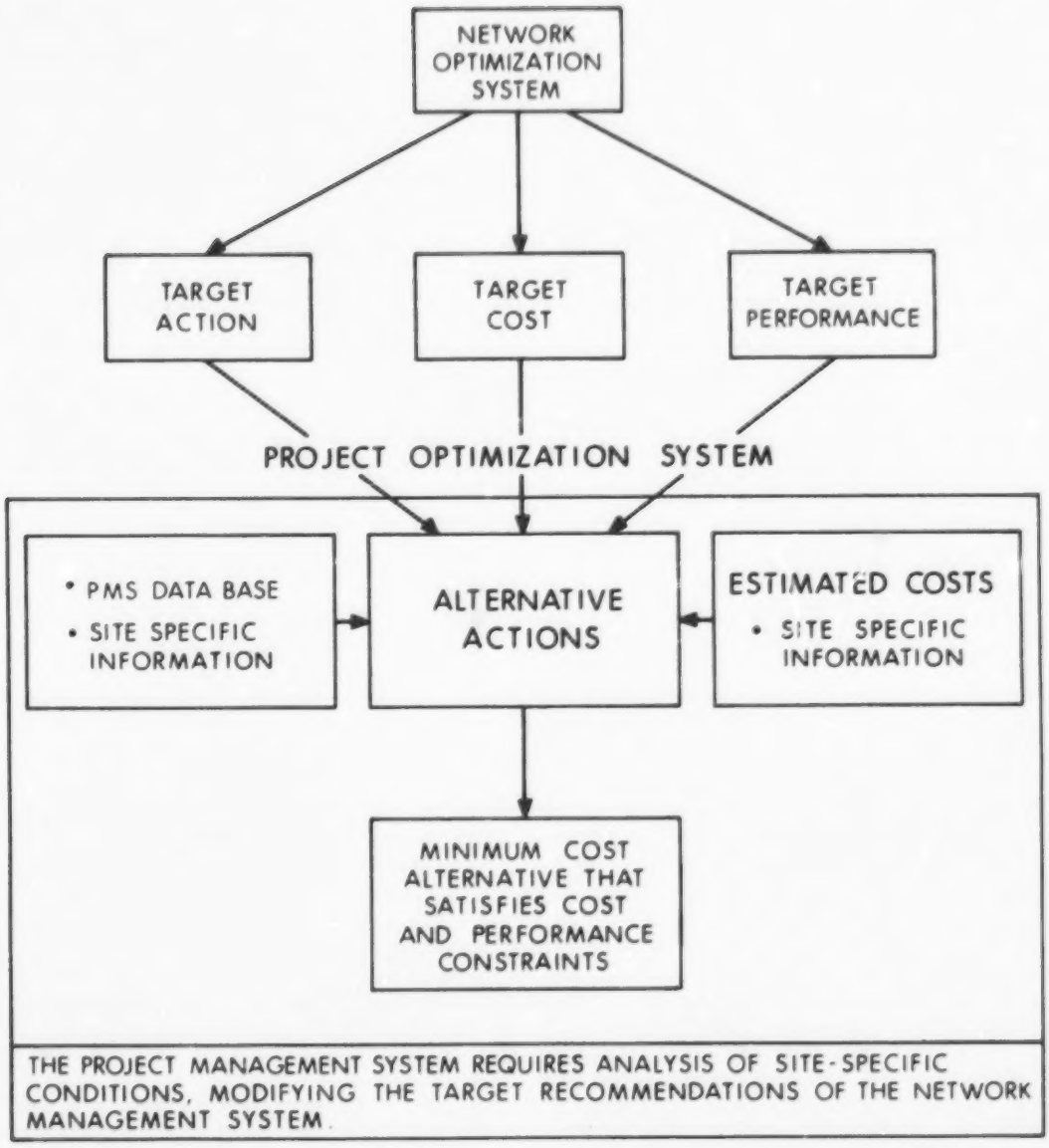

NETWORK OPTIMIZATION SYSTEM
TARGET ACTION
TARGET COST
TARGET PERFORMANCE
PROJECT OPTIMIZATION SYSTEM
• PMS DATA BASE
• SITE SPECIFIC INFORMATION
ALTERNATIVE ACTIONS
ESTIMATED COSTS
• SITE SPECIFIC INFORMATION
MINIMUM COST ALTERNATIVE THAT SATISFIES COST AND PERFORMANCE CONSTRAINTS
THE PROJECT MANAGEMENT SYSTEM REQUIRES ANALYSIS OF SITE-SPECIFIC CONDITIONS, MODIFYING THE TARGET RECOMMENDATIONS OF THE NETWORK MANAGEMENT SYSTEM.

Figure 3/ Illustrating Project Management Product

Ministry of Transportation and Communications
Ontario

URGENCY RATING: 1 DELAY; 2 SLIGHTLY DELAY; 3 NO CHANGE; 4 SLIGHTLY ACCELERATE; 5 ACCELERATE

CARD 1

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

CONTRACT No. 72515 (YR / NO) HIGHWAY No. 86 LHRS 3B290 (BEGINS) . 0.0 km (OFFSET)

PCR 78 RCR 7.0 SURVEY DATE 83 (YR.) 06 (MO.) AADT 3200

NUMBER OF DISTRESSES X 3 33 MAINTENANCE 0 0 CONTRACT LENGTH 7.1 km

URGENCY RATING 3 DISTRICT 3 W.P. No. _____ PAVEMENT TYPE HL WIDTH 6.7

LOCATION Jct Hwy 87, Jct Hwy 4 SHOULDER TYPE GR WIDTH 2.4

RIDING COMFORT RATING (AT 80 km/h): EXCELLENT 9 8 GOOD 7 6 FAIR 5 4 POOR 3 2 VERY POOR 1

CARD 2

START IN COL (2)

PAVEMENT DISTRESS MANIFESTATIONS			SEVERITY OF PAVEMENT DISTRESS: VERY SLIGHT	SLIGHT	MODERATE	SEVERE	VERY SEVERE	DENSITY OF PAVEMENT DISTRESS (EXTENT OF OCCURRENCE): FEW	INTERMITTENT	FREQUENT	EXTENSIVE	THROUGHOUT (10 20 30 50 80 100)	CHARACTERISTICS OF PAVEMENT DISTRESSES: REFLECTION CRACKING	PAVEMENT EDGE CRACK: PROGRESSIVE (30 cm from edge)	PAVEMENT EDGE CRACK: NON PROGRESSIVE (30 cm from edge)	TRANSVERSE CRACK SPACING (m)	ALLIGATOR CRACKING: ALLIGATOR BLOCK SIZE	ALLIGATOR CRACKING: DISTORTION OF ALLIGATOR AREAS
SURFACE DEFECTS	COARSE AGGREGATE LOSS	1										✓						
	RAVELLING	2																
	FLUSHING	3																
SURFACE DEFORMATION	RIPPLING	4																
	SHOVING	5																
	WHEEL TRACK RUTTING	6	✓									✓						
	DISTORTION	7																
CRACKING: LONGITUDINAL WHEEL TRACK	SINGLE	8		✓					✓	✓								
	MULTIPLE	9		✓				✓										
	ALLIGATOR	10																
MID-LANE	SINGLE	11		✓				✓										
	MULTIPLE	12																
CENTER LINE	SINGLE	13		✓					✓									
	MULTIPLE	14																
	ALLIGATOR	15																
MEANDER	SINGLE	16																
	MULTIPLE	17																
PAVEMENT EDGE	SINGLE	18		✓						✓								
	MULTIPLE	19		✓						✓								
	ALLIGATOR	20																
TRANSVERSE	PARTIAL	21		✓								✓				4		
	HALF	22		✓								✓				30		
	FULL	23		✓								✓				10		
	MULTIPLE	24																
	ALLIGATOR	25																
RANDOM																		
SLIPPAGE																		

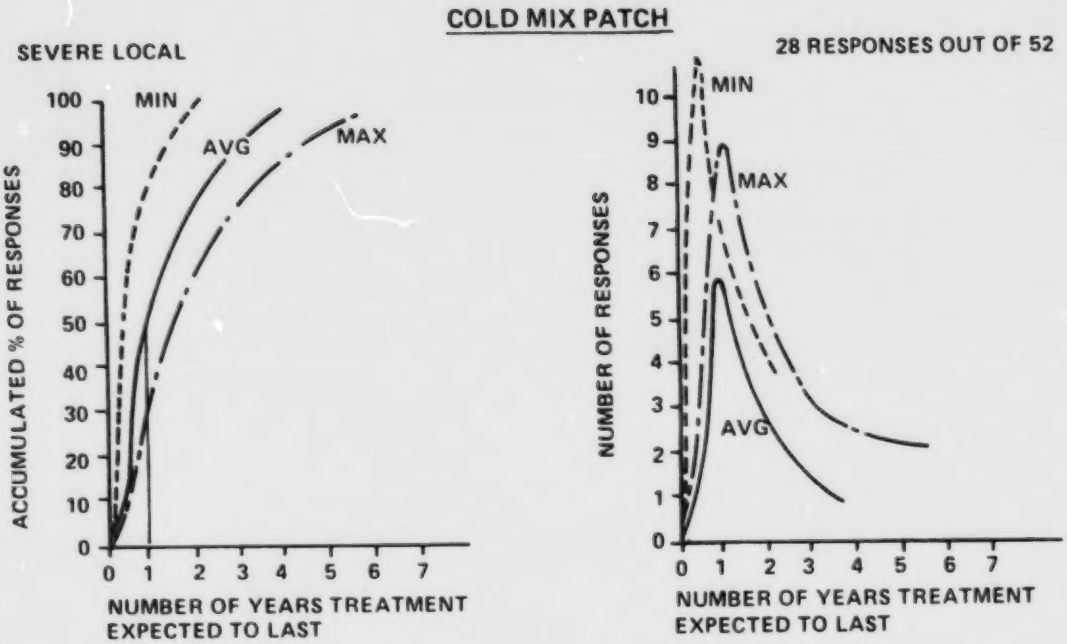
			1	2	3	4	5	6	7	8	9	10
MAINTENANCE	SPRAY	1										
	SKIN (Hot or Cold-Mix)	2										
	HOT/COLD-MIX PATCH	3										
	HOT-MIX (Full-width)	4										
	CRACK SEALING	5										
	CRACK ROUTED & SEALED	6										

REMARKS

$$DM = \sum_{i=1}^{27} C_i(S_i + D_i)$$

PH-D-39 82-04 (Formerly OB-MT-317)

Figure 4/ Flexible Pavement Condition Evaluation Form



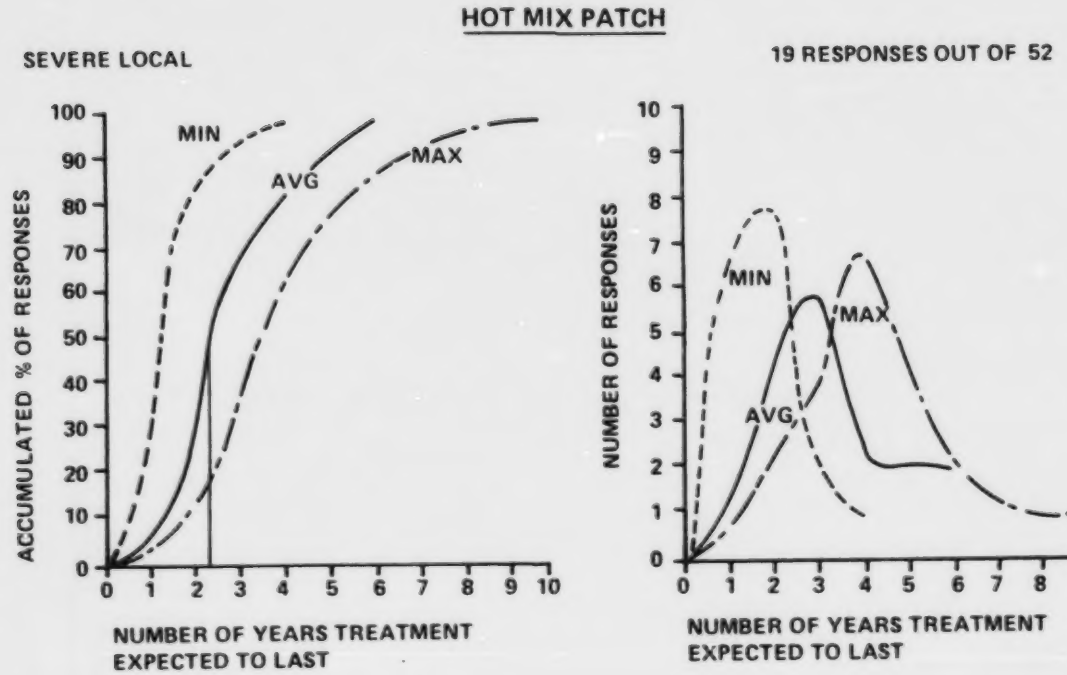


Figure 5/ "Expected Effective Life" of Maintenance for Distortion of Severe/Local Condition

DATE MODIFIED _____

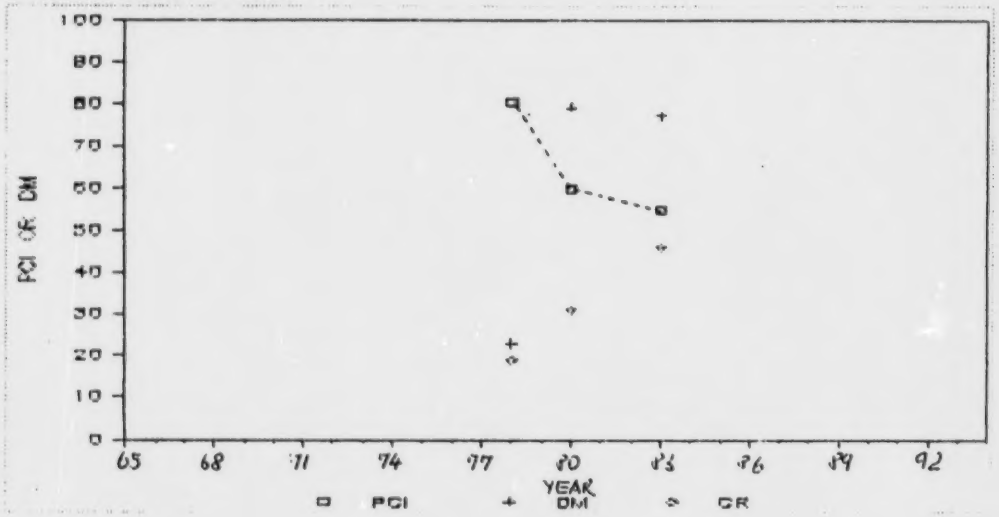
ANALYST _____

DISTRICT	HWY. NO.	CLASS	LHRS	OFFSET	LENGTH, KM	LANES	
STRATFORD	10		16540	1.3	5.3	2	FROM: SHELBURNE NORTH LIMITS N'LY
							TO: MCLANLTON (COUNTY ROAD 17)

	PAVEMENT	SHOULDER	SUBGRADE	SUBBASE AND BASE	SURFACE	OVERLAY 1	2	3
TYPE								
WIDTH, M/THICK., MM	7.3	3.0						
CONTRACT NO.					64-180			

AADT	TRUCK %	GROWTH	DRAINAGE	SKID DATA	RIDE, RQR	OTHER DEFICIENCIES
3150		5.5			5.0	

HISTORY OF PAVEMENT PERFORMANCE



SURFACE DEFECTS TOTAL 12.0 CA = 12.0

SURFACE DEFORM. TOTAL 21.0 WR = 12.0

CRACKING TOTAL 46.0 TRV = 22.5

MAINTENANCE

TYPE HOT MIX EXTENT 10-20%

TYPE _____ EXTENT _____

TYPE _____ EXTENT _____

PCR ANALYST COMMENTS: PAVEMENT DISTRESS IS MORE ACUTE IN SWAMP AREA.

EST. TERM. PCI LEVEL FOR REHAB. 50

MAINTENANCE AND REHAB. STRATEGIES FOR THE NEXT 5 YEARS	YEAR X	EXTENT %	COST $000/KM	CONSEQUENCES/BENEFITS: DEFERRAL OF REHAB. YRS.	RESULTING PCI (YEAR X)	Δ PCI 3 (YEAR X + 3)	URGENCY
RECOMMENDED: 30% PADDING + 1 LIFT (40 mm) OVERLAY	85	100	[illegible]	N/A	95	5	
DEFERRAL: 60% PADDING + 1 LIFT (40 mm) OVERLAY	87	100	[illegible]	N/A	95	5	
ROUTINE MAINTENANCE ONLY -	85	100	0.6	N/A	—	10	

Figure 6/ Action Plan Fact Sheet

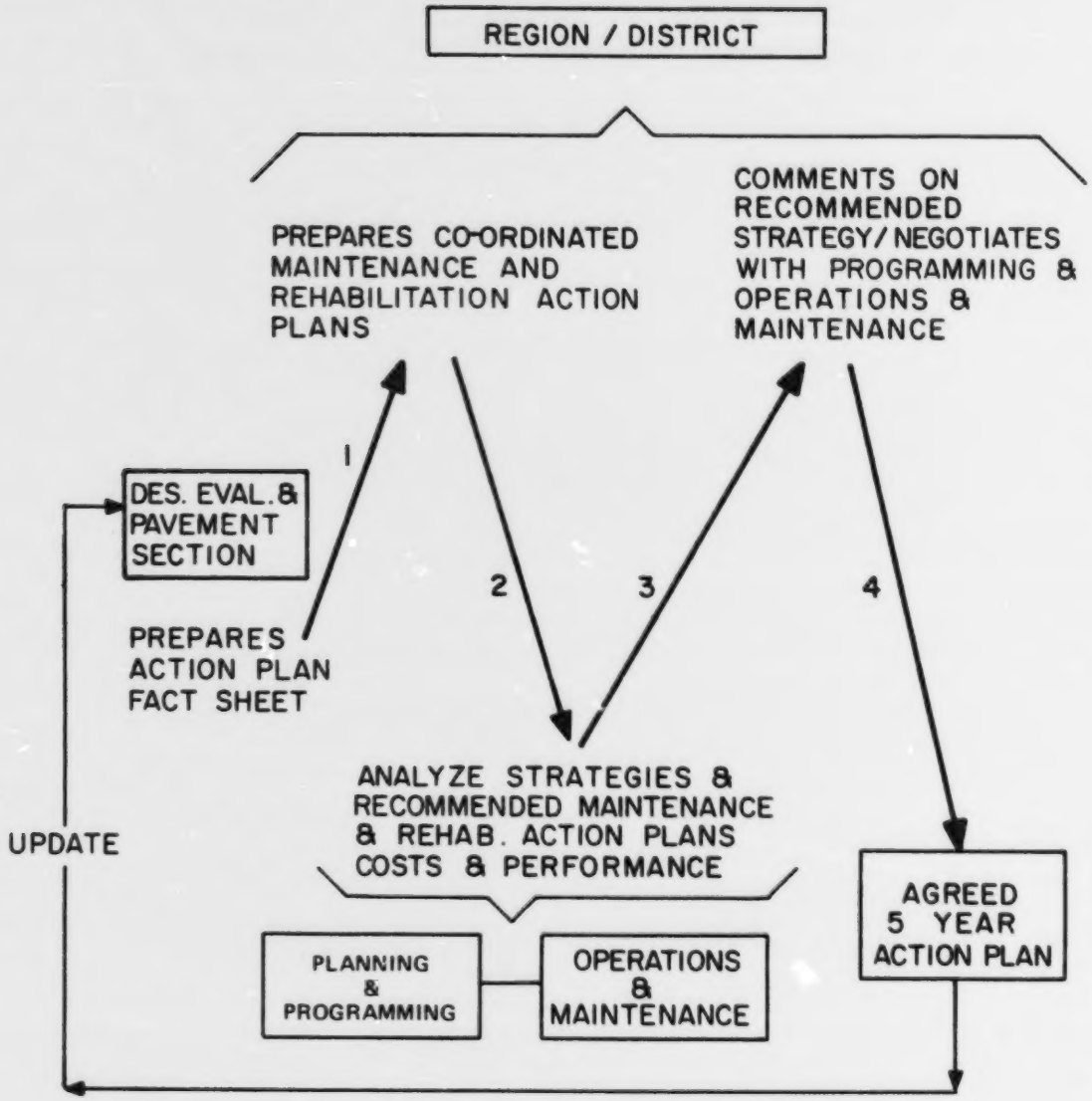

REGION / DISTRICT
PREPARES CO-ORDINATED MAINTENANCE AND REHABILITATION ACTION PLANS
COMMENTS ON RECOMMENDED STRATEGY/ NEGOTIATES WITH PROGRAMMING & OPERATIONS & MAINTENANCE
1
2
3
4
DES. EVAL. & PAVEMENT SECTION
PREPARES ACTION PLAN FACT SHEET
ANALYZE STRATEGIES & RECOMMENDED MAINTENANCE & REHAB. ACTION PLANS COSTS & PERFORMANCE
UPDATE
AGREED 5 YEAR ACTION PLAN
PLANNING & PROGRAMMING
OPERATIONS & MAINTENANCE

Figure 7/ Regional and District Roles in PMS

Ontario

Ministry of
Transportation and
Communications
Hon. Ed Fulton
Minister